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ABSTRACT

As material objects, texts are as much the product of visual semiotic codes as of linguistic ones. And throughout history, verbal texts have been combined with nonverbal, visual modes of presenting information, taking a stance toward information and readers, and organizing parts into wholes. The major challenge to creating multimodal texts in the near future will be a lack of multimedial literacy. A more fundamental understanding of existing cultural conventions in communities for combining verbal and nonverbal elements in multimedial texts is needed. To understand how meaning is made simultaneously in several semiotic modalities, common features of all semiotic systems must be identified, i.e., the presentational, the orientational, and the organizational features. Scientific and technical texts have long preserved a tradition of incorporating nonverbal visual-graphic elements as integral and normal parts of their genres. What it means to "read" a text of this kind depends on the literacy practice involved; that is, on the cultural activity as part of which meaning is being made with this text. (Contains 31 references.) (NH)

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MULTIPLYING MEANING: LITERACY IN A MULTIMEDIA WORLD

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Multimedia Texts

Literacy practices are the ways we make meaning with texts. If they are to be useful, practical skills, then they must be adapted to the real diversity of actual texts in the many communities to which we all belong. They must function within the many contexts of the actual activities in which texts play a part in our communities. For this reason alone, literacy practices cannot be usefully understood as merely linguistic practices, nor texts discussed as if they were made and interpreted only through the semiotic system of language.

Written texts, as we usually encounter them, are visual (and tactile) objects. We construe the visual patterns we see in them as written words, but we know that those words are also presented to us in some particular typeface and font, and are laid out on the page in some visual arrangement that is often relevant to interpreting their meanings. Visual information, above and beyond what is necessary to construe linguistic units, but relevant to the total potential meaning of the text in its social context is always present. As material objects, texts are as much the product of visual semiotic codes as of linguistic ones. And throughout their history, they have combined verbal text with nonverbal, visual modes of presenting information, taking a stance toward information and readers, and organizing parts into wholes.

Across all genres of texts, in all registers, in all the uses of texts in human social activity, in all our communities and subcommunities, lists, tables, diagrams, pictures, drawings, graphs, and photographs are common, normal, and essential elements of the text as a whole. The total information available in the text which is relevant to and normally used in literacy activities involving that text depends as much or more on non-verbal visual elements and codes as on the verbal elements themselves.

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Historically, our technologies have determined the normal mix between verbal and nonverbal visual elements in texts. This mix has been a compromise between economic and labor costs and the benefits of multimedia texts for particular uses. Culturally, we have created textual genres that have either striven for relative autonomy of the verbal text (unillustrated novels) or for complete integration with nonverbal visual elements (comic books). Ideologically, several generations of upper-middle class male intellectuals have tried to privilege autonomous verbal text over multimedia text, despite the fact that

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multimodal communication is historically, developmentally, and practically what human beings are most at home with.

The simple technologies for single-copy texts often make it as easy to draw as to write. Printing initially required separate processes for moveable type and pictorial material, much as some early computer systems separated text from graphics. Later forms of printing, and then xerography, made it possible to multiply copies of multimodal originals. When those originals were made by the typewriter, separate and rather difficult processes were needed to add pictorial material of comparably prestigious forms. Now computer technology is making it possible for all of us to compose multimedia texts, and to copy or distribute these with ease. True multimedia texts can now include not just verbal text, visually organized and highlighted (by size and font, placement, color, etc.), and depictive graphics (drawings, diagrams, graphs, photographic images, 3D renderings), but audio (music, voice, recordings, synthesized sound), video (created, recorded, filmed, stills and full-motion), and animation (of both text and images).

The major challenge to creating multimodal texts in the near future will be our own lack of multimedia literacy. We need to have a more fundamental understanding of multimodal communication, and particularly of the existing cultural conventions in our communities for combining verbal and nonverbal elements in multimedia texts. We need to begin to *extend* those conventions to take full advantage of the communicative resources which our new technologies are giving us. We need a general semiotic understanding of multimodal communication and multimedia literacy. Let me try to sketch out some of the elements of such a picture.

Multimodal Communication

As the ways we make meaning with texts, literacy practices are *social* and *cultural* practices in the sense that they are primarily characteristic of the communities we belong to and are only slightly distinctive from one individual to another. As social practices they are always embedded in social situations, in particular kinds of culturally recognizable activities. These activities are physical, material processes, involving bodies and other objects of the ecosystems to which our community belongs. They are part of the system of interdependent processes which constitute the ecosystem and the community. But as cultural activities, these processes also have *meanings* for us, and we enact them according to what they mean to us. As a result, the relations among our physical and material actions reflect and reinforce the relations of meaning that we attribute to them. For these reasons it is not possible to understand the material ecosystem and the cultural semiotic separately: they form a unified *ecosocial* system (Lemke 1993a).

We need to understand literacy practices as part of an ecosocial system. They are semiotic practices, meaning-making practices, character-

istic of a community (Lemke 1989a); and they are also material processes of interaction that embed our bodies in larger ecosocial systems, and without which we could not exist (cf. Lemke 1984, forthcoming). As integral parts of ecosocial systems, people and their literacy activities, are dynamic: they extend over time along the trajectories we call developmental pathways. Here, most clearly, our biological development and our behavioral development are visibly interdependent. Literacy practices develop with age and experience, and they evolve with time and cultural change. Their evolution depends on the diversity of literacy practices from one community to another.

Because literacy practices are processes of an ecosocial system, they cannot be understood solely in terms of what happens within any one individual, or in terms of what is happening at any one moment in developmental or historical time, and they cannot be understood as purely linguistic, cognitive, or semiotic processes apart from their material embodiment.

The materiality of literacy practices insures that they cannot be adequately understood in terms of any one semiotic modality, such as language. Languages, or linguistic semiotic resource systems, are analytical abstractions from embodied social practices: from speakings and writings and the activities that provide the contexts on which their cultural meanings depend. You cannot utter a lexical item, a morpheme, or a phoneme; you can only utter an acoustical sound stream replete with linguistically non-distinctive features, whose segmentation and classification into meaningful units is a miracle of coupled processes from the neurological to the cultural within an evolved, developed, self-organized ecosocial system of phenomenal complexity. The same word (as an abstracted linguistic unit) still sounds recognizably different in my mouth and in yours; and it cannot exist at all unless it is more than a linguistic word, unless it is also the unique sound made by some material system. Acoustic patterns that we can construe in that soundstream not only tell us what word of our language it most likely is, but a lot about the person who uttered it that may not be relevant to what word it is, but is very relevant to our communication with the person.

In face-to-face communication, we not only utter soundstreams, but we dance with one another: we move our bodies, from our eye-gaze and eye-blinks to our arm and hand movements, our body postures, our leanings toward and away from one another, in a complex interactional synchrony of which the soundstreams we make are an integral part (cf. Kendon 1990, Scheflen 1975). Meaningful units or meaningful acts, whether words or culturally recognizable gestures, are abstractions from this action-stream. Language co-evolved *with* other modes of meaning-making; it evolved to function in co-ordination with our construction of meaning, in semiotically-mediated action and active perception. Language *never* occurs as a pure form isolated from other kinds of meaning. In both face-to-face oral communication and in writing, the semiotics of visual and kinesthetic information is co-dependent with that of language. Our perception and interpretation of oral language and of writ-

ing also requires that we combine visual and motor processes with linguistic skills. Communication is originally, in evolution and in development, a *unitary* process. It is our cultural analytical practices that teach us to separate speech from other aspects of unified bodily processes, to separate speech from gesture, and gesture from writing, and writing from depiction.

Writing and drawing share common ancestry; each generation must be taught anew to make the separation between them. Writing is not merely the annotation of speech, as drawing is not simply the inking of images. Drawing begins as the extension to paper of gesture, as the product of lasting visual traces of our gestures in acts which are indiscriminately gesturings and drawings (cf. Arnheim 1956, cited in Kress & van Leeuwen 1990: 25). And these are accompanied you can be sure by vocalizations which are not as distinct from other gestures as the abstractions of linguistics and the ideology of intellectual verbalism dispose us to believe. It is not surprising that children do as one act what adults have been taught to separate into two: drawing and writing (cf. Dyson 1991; Hicks & Kanevsky 1992). Like our first drawing, our first writing is not a *representation* of speech, but an *extension* of it that produces a lasting visual trace.

In the progressive cultural differentiation of the action-stream of communication and the its lasting traces into speech, gesture, writing, and drawing there is a loss of unity, but there is also a semiotic gain. By a general process, common in development and evolution, sometimes called *semogenesis* (cf. Halliday 1992), when an original unity becomes semiotically construable as being composed of separable units, those units are now free to combine in new ways, making new meanings possible, and the culture is free to evolve new restrictions on these combinations, endowing them with yet another dimension of meaning (as "indices" of some subcommunity; Lemke 1993b). When writing is distinguished from drawing, it becomes possible to compose multimedia texts, incorporating both semiotic modalities, and allowing us to *multiply* the meanings made with one by those made with the other, provided our community has established conventions for how to read such texts across modes.

Every written text combines both linguistic and other, visual semiotic modalities (e.g. typographical ones). It *must*, if only because our material interaction with the text always makes it more than just a linguistic, or even visual, abstraction. It is always more for us than just an abstract graphological design, or an abstract verbal text. It is real paper (or stone, or computer screen), with real ink diffusing through the strands of cellulose, construable as writing with some particular typeface, in a particular font and point-size, laid out on the page in some particular visual arrangement -- all potentially highly relevant to what it means, or can mean, for us, not just linguistically, but typographically and even forensically. It is the materiality of the text as object, or more precisely of our ways of interacting with it as part of a literacy activity, which insures that it cannot be comprehended within the limits of any one abstracted semiotic system, linguistic or visual.

Presentational, Orientational, and Organizational Meaning

In order to understand the underlying unity of human communication, to understand how we make meaning simultaneously in several semiotic modalities (language, gesture, picture, etc.), we need to identify the common features of all semiotic systems. Once we can see all forms of symbolic expression in the same terms, we can then begin to understand how our capacity to make our meanings *specific* arises from our practices of distinguishing and combining, of *multiplying* meanings made with one system of semiotic resources (e.g., language) by those made with another (e.g., depiction).

A long historical tradition in functional linguistics, extended and generalized in the last few decades by Halliday (1978), points to three general sorts of meaning that we make in every linguistically meaningful utterance. Halliday's work has identified the specific linguistic resources by which we make these meanings, and has emphasized what was implicit in earlier accounts: that we make all of them simultaneously in every utterance. My own work (Lemke 1989b, 1990, 1992) has extended Halliday's three linguistic *metafunctions* in the context of a general social semiotics of action (Lemke 1984, 1993a, forthcoming) to three generalized semiotic functions which I believe we necessarily also enact in every meaningful action we perform. These three functions, or aspects of our meaning-making, *Presentational, Orientational, and Organizational*, define both the production and interpretation of multimedia texts. They provide the unifying framework we need to understand multimodal communication and the multiplication of meaning in multimedia texts.

Every meaning-making act constructs a *Presentational* "state-of-affairs" that construes relations among semiotic participants and processes as if they were being observed, objectively and synoptically, from some outside vantage point. In language, this is the so-called *representational* or *propositional* function, the sense in which we speak "about" something, construct a theme or topic, make predications and arguments. In less philosophical and more linguistic terms, this means that we deploy the resources of grammar and lexis to specify some process or relationship and its semantic participants (agents, patients, instruments, etc.) and circumstances (when, where, why, how, under what conditions, etc.) In visual depiction, this is the *figural* or *representational* function that presents to us a scene whose elements we can recognize and which have comprehensible relations to one another in terms of the typical scripts of that scene. This is what tells us what we are being shown, what is supposed to be "there", to be happening, or what relations are being constructed among the elements presented.

At the same time every meaning-making act constructs an *Orientational* "stance" toward that state-of-affairs, often to indicate how true or certain the producer wishes the interpreter to take it as being, or to

indicate an evaluation of it as good or bad, ordinary or suprising, in the perspective the producer is creating for the interpreter. But Orientational meaning goes naturally beyond this to also include the construction of a social relationship between producer and interpreters (present or imagined), and more generally a relative positioning of the producer and text in the whole social space of possible discourses and viewpoints on the state-of-affairs. In language, this is the *pragmatic* or *interactional* function, through which we take a role in the communication event and construct the nature of the "speech act" we are performing (informing, querying, commanding) and the social relationship to the addressee we are enacting (bullying, beseeching, promising, threatening). It is always done in the context of larger social relations and groupings that transcend any particular communicative event or text, and against the background of the various other texts in the community constructed from other possible points of view (cf. Lemke 1985, 1993c; Bakhtin 1935/1981 on heteroglossia, and commentary in Lemke 1988a, Forthcoming).

In depiction, every image takes an Orientational stance which positions the viewer in relation to the scene (e.g. intimate, distant; superior, subordinate), establishes some sort of evaluative orientations of the producer/interpreter toward the scene itself (tragic, comic; normal, surprising), and does so against the background of other possible viewpoints, and depictions, of similar scenes.

Finally, every meaning-making act constructs a system of *Organizational* relations defining wholes and parts of those wholes, both in the semiotic space of the text and in the (ecosocial) interactional space of the meaning-making act itself. Language creates words-in-phrases, phrases-in-clauses, chains of reference and cohesion, and larger and subtler structures and textures of the verbal text (Halliday's *textual* metafunction, cf. Halliday & Hasan 1976, 1989; Lemke 1988b, in press). Conversation as an activity creates in-groups and out-groups, shifting dyads within larger groups, etc. Depiction deploys *compositional* resources to organize the visual text into elements and regions, and to link disjoint regions by such features as color and texture. As material objects, depictions participate in interactions that define parts and unite them into wholes in the ecosystem where objects are viewed and used.

In recent work, Michael O'Toole (1990) and, independently, Gunther Kress and Theo van Leeuwen (1990) have demonstrated these homologous dimensions of meaning in visual semiotic productions of many kinds: paintings, sculpture and architecture; photographs, advertisements, and cinema. Kress and van Leeuwen have also considered some of the parallels between text and drawings in children's writing (1990). Their work clearly shows the usefulness of taking a "trifunctional" perspective such as that sketched here for visual semiotics, and the interesting similarities and enlightening differences between the specific meaning systems of these analytically distinct, and functionally and culturally specialized, semiotic resource systems and the genres we produce by deploying them. (O'Toole refers to *representa-*

tional, modal, and *textual* dimensions; Kress and van Leeuwen to *ideational, interpersonal,* and *compositional.*)

In an early effort (Lemke 1987) I analyzed how teachers and students made sense with each other by codeploying verbal, gestural, and pictorial resources. I found that if one regarded each of these as constituting a separate "channel" of communication, that sometimes the same or equivalent information passed nearly simultaneously in more than one channel, sometimes the information in the two channels was complementary, and sometimes information came first in one channel, and later in another. It became very clear to me that the meanings that were being constructed were JOINT meanings produced in the intersection of different semiotic systems. While it was useful to analytically separate these into different "channels," there was also an underlying unity to the meanings produced. The separation neglected a fundamental unity of communicative meaning-making that made the coordination among channels not only possible, but normal.

Since that time I have wanted to complement such work on joint visual-verbal meaning-making in spoken discourse (cf. Ochs et al. in press-a. in press-b) with studies of written text genres in which there are long and highly developed historical traditions of close co-ordination of verbal with visual elements. Since my own earlier work had studied the classroom communication of science (see Lemke 1990 and references therein), where I had found that my experience as a "native" of this subculture had been extremely useful, I decided to begin with a study of the written and graphic genres of scientific and technical discourse.

This discourse community, because of its economic resources, familiarity with new technologies, and communicative needs, is already rapidly moving toward computer-based multimedia communication (cf. Tomer 1994 on the NCSA Mosaic and Collage systems). I hope to follow its development there, and to extend the scope of my work to include educational and scholarly computer-based multimedia and hypermedia texts more generally (Lemke 1993d).

Multiplying Meaning in Scientific Texts

Scientific and technical texts have long preserved a tradition, which was somewhat suppressed in literary texts (cf. above), of incorporating nonverbal visual-graphic elements as integral and normal parts of their genres. These texts normally contain such elements as drawings and visual renderings (often the representation of observations of the natural world), schematic diagrams (abstracting theoretically critical features of a machine or complex system), maps and time-series lists and charts (which, together with tables, were probably the forerunners of true quantitative graphs; cf. Tufte 1983); two-dimensional tables whose elements may be verbal, numerical, or graphic; and bar- and line-graphs (representing quantitative codependence of variables in experiments or according to theoretical predictions). Contemporary

texts frequently include photographs of items studied, and reproductions, often in color, of computer models and simulations, frequently in three-dimensions. New technologies, such as CD-ROM and laser disks, as well as the computer-based multimedia and hypermedia systems already mentioned, are adding to this mix audio and full-motion video elements as well as animations and simulations, again often in 3D.

In a recent preliminary survey of 43 journal articles and book chapters occupying over 400 pages of text in several scientific and technical research publications, there were, on average, at least one, and sometimes as many as 4, nonverbal visual displays per page of running text. This does not include mathematical expressions of which there were an average of an additional one to three (and up to as many as 7) per page, depending on subfield.

It is an interesting question how we should count mathematical equations that appear as part of a text, expecially when they are visually set off in page composition (usually standing along on their own line with whitespace above and below). They are not strictly speaking part of the verbal text, though they can be read aloud in a variety of ways (by symbol names, in mathematical English, or in a mix of mathematical register and that of the technical register whose lexical items and semantic relations their symbols conventionally represent). They are visual and nonverbal, and depend on a semiotic system which may be an extension of natural language semantically, but which is also one that has some degree of autonomy as a system of signs.

In 20 articles (62 pages) comprising two issues of *Physical Review Letters*, a journal for brief communications of significant new experimental or theoretical results in all areas of physics, there were an average of 1.2 distinct graphic elements (graphs, diagrams, tables, etc.) per page of running text, and an additional 2.7 mathematical equations per page. It was not unusual to find 3 graphic elements on a single page, or 6 equations. Experimental articles have more graphic items, theoretical articles more equations, in general.

In 31 articles (75 pages) comprising two issues of *Science*, a journal for brief communications of significant new findings mainly in the biological and earth sciences, excluding mathematics expressions and tables, there were 2.0 graphic elements per page on average, and relatively few equations (tables were common, about one per article).

In a later survey, looking at *Science* and its British twin *Nature*, for articles particularly rich in the diversity of their graphic elements, a sampling of 10 articles (total 40 pages), had an average of 3.6 such elements per page (excluding mathematical expressions and tables).

A typical page of the texts of these genres shows a visual layout which is quite rich in its organizational complexity. It may contain headers and footers, with verbal text and numberings. It will usually have two or three vertical columns of the Main Text, incorporating occasional mathematical expressions set on their own lines, but often

punctuated as if grammatically part of the embedding sentences. These columns will be interrupted by tables, and suspended over portions of the page to accomodate larger figures containing one or several graphic elements, typically line graphs, diagrams, and photographs. Each of these will have a Caption, sometimes as extensive as the main text on that page, which takes the form of verbal text, sometimes itself incorporating mathematical equations.

It is certainly *not* true that the verbal text contains all of the significant information presented in the article. Generally experimental data and many key relationships and patterns are presented *only* in tables or graphs, or in equations, and are not repeated in the verbal text. Much critical information is contained in the captions that is not mentioned in the Main Text. The information in the figures is generally not correctly or adequately interpretable without reference to the caption for that figure. There seems to be a convention that Figures-and-Captions, as a graphic-verbal unit, should be relatively self-contained. It is often not necessary to refer to the Main Text to understand what is presented in these units, though it is necessary to do so to find what the authors consider to be the significance of what they present. The Figure-and-Caption unit seems to express the ideology of this community that factual information can and should be separated from its interpretation. Figure-and-Caption units tend to construct themselves as purely factual presentations. For this purpose, Tables are also Figures.

What does it mean to *read* a text of this kind? We have to recognize that the answer depends on the literacy practice involved; that is, on the cultural activity as part of which meaning is being made with this text. In this community, for example, there is a literacy practice of "consulting" an article in order to find a specific item of information, often a numerical value for some observation or a specific equation (representing a theoretical model). One may consult the article also to identify a particular "claim" by the authors (for purposes of citation or refutation), but one may also consult it to look at the shape of a curve (as in a line graph) or the topological connectivity of a gene map, a model of a protein, or the basins of attraction of some complex dynamical system. In short, not only does one often look for purely visual-graphical information in the text, but in searching for any information one is likely to need to refer to both verbal text and graphical elements and construe the conventional relations between them appropriate to this genre.

At the other extreme, there might be a "complete reading" of the text, for the purposes of preparing to be tested on it or for debating its contents privately or publicly with its author. Such comprehensive readings of a text are very rare, I believe. The texts of these genres, unlike, perhaps, those of textbooks or of more synthetic expositions of a subject, are not really meant to be read linearly from start to finish. They are more like encyclopedia entries. One *can* read them completely, but one is more likely to read only parts of them. The most visually prominent elements of these texts are the Figures,

followed often by the Abstracts, and I believe these are the parts most often read. The least visually prominent are the References or citations to other articles, any one of which a reader might consult, but which no reader is likely to read comprehensively.

Strangely, perhaps, Captions are visually prominent more by their length in some texts than by their other visual features. They are usually printed in typefaces much smaller than those of the Main Text, despite the fact that the information they contain is usually essential to interpreting the Figures, and so to extracting what is for many readers the most important information in the text. Captions are supposed to be subordinated to their Figures, and Figures, by some accounts, are subordinate to Main Text, but in the dominant literacy practices of the community, Figures are very nearly co-equal with Main text in importance, and their Captions are an integral part of them. I think we can safely predict that in the era of hypertext links, the successors to Figure captions will normally be presented in the same size text as the verbal Main text, and that this will be quietly received in the community as an improvement in the genre.

In a relatively complete or comprehensive reading of texts of this genre, a typical reader would begin with her point of entry to the text, usually a keyword in the title or the name of the author, which makes the text relevant to some task. The Abstract would be read cursorily as a preview of the text (it is read carefully only in order to decide *whether* to read it). The visually prominent figures might attract attention and lead to a survey of them, with occasional references to the captions for clarification. If the specialty field is less familiar, the captions become essential to interpreting the figures. If the field is highly familiar (and remember that most readers of these texts are other experts in the specialty), they will be read only for technical details, and probably later. One might scan the references at the end to see if one's own work is cited, or to see if reference is made to some other particular article, author, or research group.

In reading comprehensively, the Main Text is only a spine. The main text itself frequently refers the reader to other material: most frequently to citations of references, or to the Figures-and-Captions. A caption may back-refer ("see main text"), or cross-refer ("see Figure X"), and may also cite references. This is already a miniature of the hypertext paradigm, in which various units of the total available text cross-refer at various points to one another, and in which there are many possible pathways through the textworld, not all, or even most of which, necessarily pass through every unit of text. Reading this genre is a highly non-linear process.

The basic relations of Main Text to Figure, and of Figure to Caption, highlight the constant co-ordination of verbal meanings and visual-graphical meanings that are necessary to interpret the text. Even within a Figure, there are verbal and quasi-verbal (symbolic) "labels" that indicate the meanings of the abstract visual elements presented,

and which make it possible for verbal text to cross-refer to visual elements within a Figure ("as appears at point A of Figure 3"). What the words of the text mean depend on our being able to co-ordinate them with elements of the Figures, and the identity and interpretation of visual elements in the Figures depends on the accompanying verbal text.

Verbal meanings are *more specific* when they are coupled with visual elements in a Figure ("the relation between lines A and B in Figure 4"), often in ways that *cannot* be equivalently specified in purely verbal terms (there is no vocabulary for describing the global relationships between two arbitrary curved lines, for example), but which are immediately apprehended by the visually trained specialist. And visual relations take on added, indeed more specific, significance, when they are contextualized by the verbal text. This is an instance of the general principle of *multiplicative meaning* in multimodal texts. If we have a set of words, and a set of pictures, that are not in one-to-one correspondence with each other, but which may be freely combined in different ways, then the set of *possible* meanings is enlarged to be the *product* (not the sum) of the meanings that can be made with each set separately. Any *actual* combination of a word and a picture is one instance drawn from this product, and so its meaning is specific in that higher degree. (Thus, if we had five words and four pictures, each word has a specificity of one in five, each picture a specificity of one in four, but each word-picture combination has a specificity of one in twenty.)

In an idealized single semiotic modality, language as viewed by linguists, say, the three generalized semiotic functions or aspects of meaning in every utterance also combine in this way. So the meaning of an utterance is threefold specific: for its Presentational or thematic-propositional meaning, for its Orientational or interactive-attitudinal meaning, and for its Organizational or structural-compositional meaning. What happens when we have now two semiotic resource systems jointly deployed as in a multimedia text?

We must first recognize that it is not true in practice that all possible combinations of meaning elements are equally likely. If this were so there would be no culture. Cultural patterns *are* the skewed probability distributions (metaredundancy relations, cf. Lemke 1984) that tell us that if we find one meaning element in some context then we are more likely to find some others with it, and that if we find some combinations together, we are more likely to be in a particular context (and a particular subculture). *Genres* are such patterns, viewed synoptically, as the product of changing likelihoods of transitional probabilities (Halliday 1992, Lemke 1991): first this meaning element (or combination), then more likely this one than that one.

Subject to these limitations, which invite us to specify the conventions of a particular genre in a particular field of discourse, we see that, to a first approximation, the Presentational meaning elements from each of, say, two semiotic modalities multiply each other to in-

crease the specifity of any possible Presentational meaning in the joint multimodal text, and the Orientational elements multiply one another similarly, and so do the Organizational elements.

Perhaps we should call this the second, rather than the first, approximation since there is a prior (physicists might call it the zeroeth approximation) relation: the multiplication of the Presentational, Orientational, and Organizational meanings of each unit within a single semiotic, in the units of the verbal text itself, or in the units of, say, the Figure itself.

Is it then possible for, say, a Presentational meaning element in a Figure to contribute to the Orientational meaning of the whole, cross-multiplying with an orientational meaning element in the verbal text? Indeed it is, at least insofar as there tend to be consistent patterns across metafunctions. An alternative analysis, which has the virtue of making the relations appear simpler, would say that in this case the visual Presentational element is actually contributing as well to the Orientational meaning in its own semiotic because it is a convention of the genre that such Presentational elements tend to occur only with this particular Orientational meaning, and so their very occurence implies, within the genre, this Orientational meaning, which then combines by the original rule with the Orientational meaning elements of the other semiotic.

Commonly, for instance, a graph of experimental data points will indicate with error bars the uncertainty in a measurement. This is Presentational information within the graphic semiotic insofar as it tells us what the estimated probable error of the measurement is. But it also contributes to the Orientational meaning of the graph as a whole, since it indicates the degree of certainty or uncertainty which the authors are constructing for their claim as to the numerical value of the measurement itself. By convention, large error bars indicate less certainty. We would then expect to find, in the verbal text, some characteristic signs of modalization in the corresponding claim, orientational meaning expressed by such markers as "it may be that" or "it is likely that" or even "we believe that" (in which "believe" is both a Presentational process, and an Orientational modality, contrasting with both "understand" -- a different process -- and with "suspect", the same process, but with a lesser claim of certainty).

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